they lie in separate chromosomes. Further the gene for the character of the base of the grain segregates independently of the color genes. It, therefore, probably lies in a fourth chromosome. The seven characters given in table 1 are very closely if not absolutely linked with the character of the base. If these seven characters may be supposed to be due to separate pairs of genes these must lie in this fourth chromosome.

Still a ninth pair of genes is located in this fourth chromosome, viz., that for smoothness (lack of pubescence) on the back of the upper grain. This gene is apparently located at a slight distance from the group discussed above since it shows about 1.5% of crossovers with the members of that group.

The gene for pubescence on the back of the lower grain is linked with the gene for black color and is, therefore, to be regarded as located in the same chromosome. The per cent of crossovers between these two genes is probably less than 0.7%.

[1] This is an abstract of paper No. 95 from the Biological Laboratory of the Maine Agricultural Experiment Station. The complete paper is now in press in *Genetics*.

[2] A spikelet of common oats usually bears two grains. The larger of these is called the "lower" grain and the smaller one the "upper" grain. The upper grain is articulated with the lower by means of a short pedicel.

A COMPARISON OF THE RATES OF REGENERATION FROM OLD AND FROM NEW TISSUE

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In determining the factors of regeneration one of the questions that arises is the extent to which rate of growth of the new organ is controlled by the character of the cells at the cut surface. Is regeneration wholly a matter determined by the characteristics of the local cells or is the process under more central control? If the former is true, change in the condition of the cells near the cut surface should modify the rate of regeneration, if the latter, such change does not necessarily mean change in rate.

The present study consists of a comparison of the rate from newly regenerated tissues with that from old tissues. When a portion of the tail of a frog tadpole is removed by a transverse cut there is near the cut surface a considerable degree of reorganization of the cells which are to give rise to the new organ. If, before the completion of regeneration, a second removal is made the regeneration will be from new cells if the second cut is distal to the level of the first and from old cells if it

is proximal to that level. In order to insure equality of level the first cut was made at *A* in the figure for a new tissue basis and at *B* for an old tissue basis, the second regeneration level, in each case coming between *A* and *B*. If rate control is a function merely of the readiness of the cells the second regeneration from the new tissue level should be more rapid than that from the old tissue level.

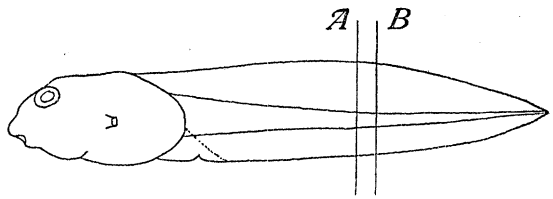

FIG. 1

Three groups of experiments were made on tadpoles of the green frog, Rana clamitans. In each it is clear that there is no striking difference between the rates from the two kinds of cells.

In experiment I the average regenerated length in ten individuals at the end of six days is 2.16 mm. from old tissue and 2.15 mm. from new tissue. The removed lengths are not exactly alike in the two cases and it is necessary to make a correction for the difference. It is shown elsewhere that within the limits of the present experiment rate of regeneration is directly proportional to length removed. The specific length regenerated or length per unit of removed length is therefore a constant within these limits. It is therefore fairer to use the specific than the absolute lengths. The specific lengths regenerated in the present experiment at six days are 0.196 for old and 0.204 for new tissue.

In the same experiment at eight days the average lengths are 3.19 mm. from old tissue and 3.12 from new and the specific lengths are respectively 0.303 and 0.310.

These values are given in table 1.

TABLE 1

COMPARISONS OF REGENERATIONS FROM OLD AND NEW TISSUE IN THE TAIL OF THE TADPOLE OF RANA CLAMITANS. SERIES 3628–3675

	TOTAL LENGTH	TAIL LENGTH	REMOVED LENGTH	REGENERATION TIME SIX DAYS		REGENERATION TIME EIGHT DAYS	
				Regenerated length	Specific length regenerated	Regenerated length	Specific length regenerated
	mm.	*mm.*	*mm.*	*mm.*		*mm.*	
Average from old tissue.	32.9	21.5	11.3	2.16	0.196	3.19	0.303
Average from new tissue.	34.0	22.2	10.7	2.15	0.204	3.12	0.310
Old—ahead.....				0.01		0.07	
New—ahead.....					0.008		0.007
Old—times ahead.....				4	$3\frac{1}{2}$	3	3
New—times ahead.....				6	$6\frac{1}{2}$	3	3

In experiment II similar data were obtained for four, six, eight, ten, twelve and a half, eighteen and fifty-six days of regeneration. The removed lengths are quite different in the different individuals so that specific lengths alone are valid. Giving the old tissue level first in each case and using only removals of over 4 mm. these values for the seven times are respectively 0.043 and 0.045, 0.135 and 0.143, 0.216 and 0.224, 0.292 and 0.293, 0.331 and 0.337, 0.352 and 0.348, and 0.345 and 0.346. They are given in more detail in table 2.

TABLE 2

COMPARISON OF REGENERATIONS FROM OLD AND NEW TISSUE IN THE TAIL OF THE TADPOLE OF RANA CLAMITANS. SERIES 3676-3765

DAYS OF REGENERATION	OLD TISSUE SPECIFIC LENGTH OF REGENERATION	NEW TISSUE SPECIFIC LENGTH OF REGENERATION	OLD AHEAD	NEW AHEAD
4	0.043	0.045		0.002
6	0.135	0.143		0.008
8	0.216	0.224		0 008
10	0.292	0.293		0.001
12½	0.331	0.337		0.006
18	0.352	0.348	0.004	
56	0.345	0.346		0.001
Average				0.003

Similar results were obtained when the removed lengths were under 4 mm.

In experiment III completed lengths from old and new tissue are compared in each of the third, fourth and fifth regenerations. It is necessary to point out that in the tadpole tail the completed regeneration is always less in length than the removed tail. The comparison here therefore concerns the degree of replacement of the lost part and not its rate. The average regenerated lengths giving the old tissue levels first are 7.9 mm. and 7.9 mm. for the third, 5.3 and 5.5 for the fourth and 6.6 and 5.9 for the fifth successive regeneration.

The data as a whole show clearly that there is no essential difference between rate of regeneration from new cells and from old cells. There is only a very slight advantage in favor of the new cells while a striking one would be expected if rate were largely determined by local cell characteristics. Rate of regeneration seems therefore to be under central control. This conclusion is in agreement with the results of experiments on other factors.

The full data will be published in the *University of Illinois Biological Monographs*.